



A Publication
of Reliable Methods
for the Preparation
of Organic Compounds

Working with Hazardous Chemicals

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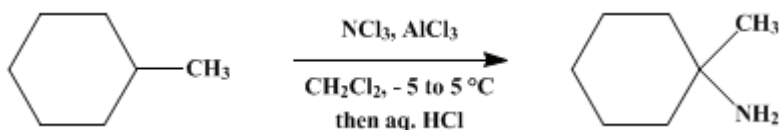
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These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

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1-AMINO-1-METHYLCYCLOHEXANE

[Cyclohexylamine, 1-methyl-]



Submitted by Peter Kovacic and Sohan S. Chaudhary¹.
Checked by R. A. Haggard and William D. Emmons.

1. Procedure

Caution! The reactions should be carried out in a hood behind a protective screen since trichloramine is noxious and potentially explosive; however, no difficulties from decomposition have been encountered under the conditions described.

A. *Trichloramine*. A mixture of 600 ml. of water (Note 2), 900 ml. of methylene chloride (Note 3), and 270 g. (1.32 moles) of calcium hypochlorite (Note 4) is cooled to 0–10° in a 3-l., three-necked, vented flask equipped with a stirrer, a thermometer, and a dropping funnel. A solution of 66.0 g. (1.23 moles) of ammonium chloride in 150 ml. of concentrated hydrochloric acid and 450 ml. of water is added dropwise with stirring over a 1-hour period at 0–10°. After an additional 20 minutes of stirring, the organic layer is separated, washed with three 200-ml. portions of cold water, and dried over anhydrous sodium sulfate. The yellow solution is filtered, and the trichloramine concentration is determined by iodometric titration (Note 5).

B. *1-Amino-1-methylcyclohexane*. A 3-l. three-necked flask is fitted with a paddle stirrer, a condenser, a thermometer, and a dropping funnel with an extension for below-surface addition. Provision is made for introduction of nitrogen by use of a side-arm adapter. The vessel is charged with 196 g. (2.0 moles) of methylcyclohexane (Note 6) and 106 g. (0.80 mole) of anhydrous aluminum chloride. A solution (ca. 600 ml.) of trichloramine (0.40 mole) in methylene chloride is added with efficient stirring over a period of 2 hours at –5° to 5° (Note 7). Throughout the reaction a stream of nitrogen is passed through the flask (Note 8). The brown mixture is stirred for an additional 20–30 minutes at the same temperature.

The reaction mixture is then added with good stirring to a slurry of 800–900 g. of ice and 50 ml. of concentrated hydrochloric acid (Note 9). The layers are separated, and the dark organic layer is washed with three 100-ml. portions of 5% hydrochloric acid and discarded. Traces of non-basic organic material are removed from the combined aqueous layer and washings by extraction with pure ether (Note 10) until the extract is colorless. The aqueous solution is treated with 600 ml. of 50% aqueous sodium hydroxide (Note 11) with cooling, and the basic organic product is extracted with three 125-ml. portions of pure ether (Note 10). The ethereal solution is dried over sodium sulfate, and the solvent is distilled on the steam bath to give 42–46 g. of a clear, amber product (Note 12). To this crude product is added 10 g. of triethylenetetramine (Note 13). Distillation through a small Vigreux column yields 21.5–30 g. (48–67%, based on trichloramine) of 1-amino-1-methylcyclohexane, b.p. 44–49° (20–25 mm.), n_D^{25} 1.4516 (Note 14).

2. Notes

1. The stoichiometry of the reaction is not known.
2. Deionized water is used throughout.
3. Commercial methylene chloride was distilled before use by the submitters. The checkers used reagent grade methylene chloride without distillation.

4. Calcium hypochlorite is obtained as "HTH" (Olin Mathieson Chemical Co., 70% purity).
5. Iodometric determination of positive chlorine is carried out as follows: 2.0 g. of potassium iodide or sodium iodide is dissolved in 10 ml. of water, and 40 ml. of glacial acetic acid is added. Into this solution is pipetted 1.0 ml. of the methylene chloride solution of trichloramine. The liberated iodine is titrated with 0.100N sodium thiosulfate. The solution is found to be 0.6–0.7M in trichloramine. Storage for several days at 0–5° results in negligible decomposition, although it is not recommended unless adequate safety precautions are observed. Excess methylene chloride-trichloramine solution can be conveniently disposed of by its slow addition to a cold, stirred, dilute aqueous solution of sodium metabisulfite.
6. A pure grade of methylcyclohexane (Eastman Organic Chemicals) is used. Subsequent to the checking of this preparation, the submitters reported 69–72% yields with 78.4 g. (0.80 mole) of methylcyclohexane.² In this case a 1-l. three-necked flask is employed for the reaction; the remainder of the procedure is unchanged.
7. Cooling is accomplished with either an ice-salt bath or preferably a dry ice-acetone bath. The time of addition can be reduced to 1 hour by use of the latter. However, if the temperature is much below that designated, unchanged trichloramine accumulates, resulting eventually in an uncontrollable reaction.
8. Purging with nitrogen results in some increase in yield. If the flow is too vigorous, trichloramine is lost by volatilization.
9. The mixture can be stored overnight at this stage.
10. High-purity ether (e.g., Baker Analyzed Reagent) is used since a grade of lower quality gives a product that is more difficult to purify because of contamination with alcohol.
11. Excess sodium hydroxide is needed to dissolve the aluminum-containing precipitate.
12. The last portion of solvent is carefully removed at the water aspirator.
13. Triethylenetetramine (redistilled, Eastman Organic Chemicals) prevents bumping and foaming and acts as a chaser for the distillation.
14. The product contains less than 10% of lower-boiling impurities determined (by the checkers) by vapor-phase chromatography with a column packed with 15% XF-1150 on Chromosorb W. Further purification can be effected readily with good recovery by drying over sodium hydroxide pellets and fractionating at atmospheric pressure through an efficient spinning band column, with collection of the fraction, b.p. 142–146°, n^{22D} 1.4522.

3. Discussion

In addition to the present method,² 1-amino-1-methylcyclohexane has been synthesized by the following procedures: Ritter reaction, e.g., with 1-methylcyclohexanol (76%, 67%)^{3,4} or 1-methylcyclohexene (35%);⁴ Hofmann reaction with 1-methylcyclohexanecarboxamide (80% as hydrochloride);⁵ reduction of 1-methyl-1-nitrocyclohexane (63%);⁵ Schmidt reaction with 1-methylcyclohexanecarboxylic acid (42%).⁶

4. Merits of the Preparation

This procedure constitutes the first example of one-step conversion of a *t*-alkane to the corresponding *t*-alkylamine. Other hydrocarbons in this class, such as isobutane, have also been aminated with good results.⁷ Only a very limited number of convenient routes, e.g., the Ritter reaction, are available for the preparation of *t*-carbinamines. The present preparation illustrates a simple method that utilizes a novel substrate.

References and Notes

1. Department of Chemistry, Case Western Reserve University, Cleveland, Ohio 44106.
2. P. Kovacic and S. S. Chaudhary, *Tetrahedron*, **23**, 3563 (1967).
3. H. J. Barber and E. Lunt, *J. Chem. Soc.*, 1187 (1960).
4. W. Haaf, *Ber.*, **96**, 3359 (1963).
5. K. E. Hamlin and M. Freifelder, *J. Am. Chem. Soc.*, **75**, 369 (1953).
6. C. Schuerch, Jr., and E. H. Huntress, *J. Am. Chem. Soc.*, **71**, 2233 (1949).

Appendix
Chemical Abstracts Nomenclature (Collective Index Number);
(Registry Number)

sodium metabisulfite

methylene chloride-trichloramine

hydrochloric acid (7647-01-0)

acetic acid (64-19-7)

ether (60-29-7)

ammonium chloride (12125-02-9)

sodium hydroxide (1310-73-2)

sodium sulfate (7757-82-6)

potassium iodide (7681-11-0)

sodium thiosulfate (7772-98-7)

nitrogen (7727-37-9)

iodine (7553-56-2)

aluminum chloride (3495-54-3)

chlorine (7782-50-5)

sodium iodide (7681-82-5)

methylcyclohexane (108-87-2)

methylene chloride (75-09-2)

calcium hypochlorite (7778-54-3)

1-methylcyclohexene

1-Methylcyclohexanecarboxylic acid (1123-25-7)

1-Amino-1-methylcyclohexane,
Cyclohexylamine, 1-methyl- (6526-78-9)

trichloramine (10025-85-1)

triethylenetetramine (112-24-3)

1-Methylcyclohexanol (590-67-0)

1-methylcyclohexanecarboxamide

1-methyl-1-nitrocyclohexane

isobutane (75-28-5)